Space Weather Technical Forecast

Issued on Friday, 27 October 2023 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Coronal hole enhancement Days 3-4 (29-30 Oct) with G1-G2/Minor to Moderate Geomagnetic Storms likely.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Moderate with occasional C-Class flare activity and a peak M1.4 flare at 26/2324 UTC from a filament lift-off close to the north eastern limb.

There are currently six sunspot regions on the disc. There are two regions in the south west disc, which are both small, although AR3471 is currently the most complex region on the disc, having recently developed rudimentary penumbra and a number of intermediate spots. AR3473, in the north east, continues to emerge from the eastern limb and is currently a small sunspot group contained within a relatively large area of plage. The other regions are small and simple.

No Earth-directed CMEs have been observed in available imagery. The recent M-flare produced a CME that has been analysed to clearly miss, passing behind the Earth. Additionally, recent partial disruptions of a couple of small filaments on the visible disc do not appear to have produced CMEs.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, showed a likely connection to a HSS from CH64/+. Solar wind speeds increased from around 390km/s to 480 km/s at the start of the period, fluctuating between slightly elevated and elevated levels 26/1700-2100 UTC with a peak around 540 km/s. Although initially average, density was mostly below average. Since 27/0900UTC density has been on a slight upwards trend. The Interplanetary Magnetic Field (IMF), Bt, has been moderate with a peak of 12nT, but decreased to weak around 27/1000 UTC. The north-south component, Bz, has been mostly orientated southward and has fluctuated between weak and moderate levels, ranging between +10 and -10nT. However, it has largely been weak and fluctuating since around 26/2100 UTC. Phi angle has remained positive (away from the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4) with a G1/Minor Geomagnetic Storm (Kp 5) interval 26/2100-2359 UTC. Activity has reduced in recent intervals to predominantly Quiet or Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was largely at background levels. Associated 24-hour fluence remains well below the Active (1e8 integrated pfu) threshold. The observation at 27/0000UTC was 1.29e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Low activity forecast with occasional C-Class flares. There is a slight, but increasing, chance of isolated M-flares. This increase is dependent on the development of sunspot regions on the disc, or the arrival or return of sunspot regions to the visible disc.

Solar Wind / Geomagnetic Activity: There are no Earth directed CMEs expected. Current solar wind enhancement likely due to a connection to CH64, with speeds expected to return to background levels and benign conditions during the next 24hrs. The next enhancement is then

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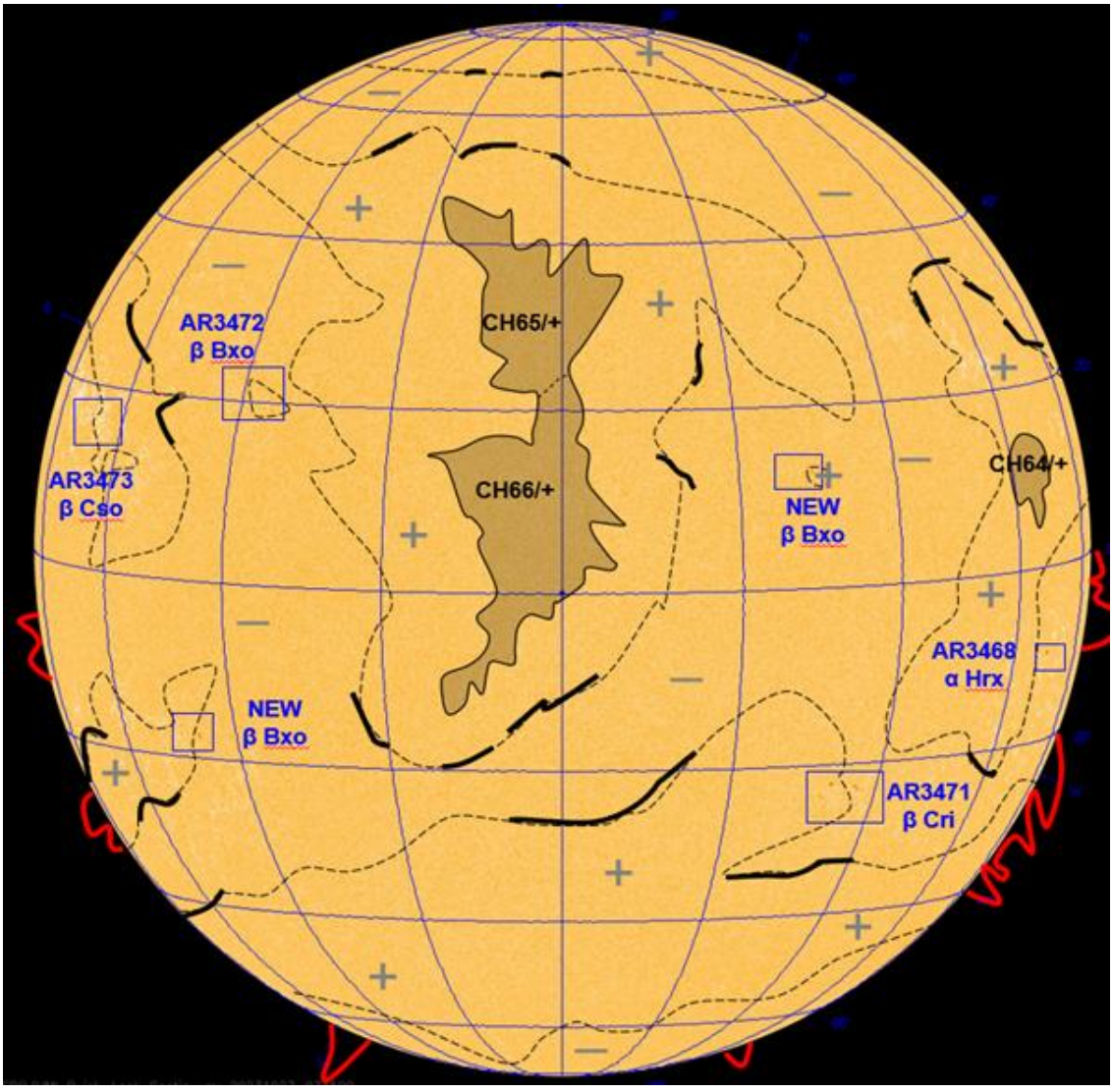
expected Day 3 (29 Oct) or early Day 4 (30 Oct) from large coronal holes CH65 and CH66 which are currently approaching centre disc, with speeds become elevated or possibly strong. Quiet to Unsettled geomagnetic activity is expected Days 1-2 (27-28 Oct) with a diminishing chance of an Active (Kp 4) interval. G1-G2/Minor to Moderate Geomagnetic Storms (Kp 5-6) are increasingly likely Days 3-4 with the onset of HSSs and any associated CIR.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at Background. High energy electron flux (greater than 2MeV) is expected see a small increase from background due to recent solar wind interactions with the Van Allen Belt, with a chance of reaching High at diurnal peak by Day 2 (28 Oct). The associated 24 hour fluence is forecast to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 27/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs forecast.

The current solar wind enhancement has been attributed to a HSS from CH64/+. A reduction in speeds has been observed, with values likely falling to, or close to, background levels over the next 24hrs. A return to more benign conditions is expected Day 2 (28 Oct) ahead of the next enhancement from the large coronal holes CH65 and CH66 with the associated HSS due to arrive Day 3 (29 Oct) or early Day 4 (30 Oct). SWPM is not considered to provide a good steer on the potential wind enhancement, due to the non-recurrent nature of these coronal holes and influence from CMEs during the last rotation. Wind speeds are anticipated to increase to elevated, possibly strong levels 550-700 km/s.

MOSWOC ENLIL assessment of the solar wind environment is currently low confidence as the model both lacks the current enhancement associated with CH64/+ and is thought to bring the onset of fast winds from CH65/+ and CH66/+ on Day 2 at least a day earlier than current expectations. These coronal holes are not thought to be a recurring feature, however, the early onset produced by Enlil may be the result of modelling the return of CH54/+ which was significantly more advanced on the disc than CH65/+ when looking at a comparison of SDO AIA-211 imagery.

There is the potential for enhancement emanating from a CIR which is likely to precede the arrival of the coronal hole high speed stream. There may also be additional influence from any SSBCs in the intervening period.

Quiet to Unsettled geomagnetic activity is expected Days 1-2 (27-28 Oct) with a diminishing chance of an Active (Kp 4) interval. G1-G2/Minor to Moderate Geomagnetic Storms (Kp 5-6) are increasingly likely through Day 3 into Day 4 (29-30 Oct) with the expected onset of coronal hole fast winds and any associated CIR. There is a chance of some enhancement to Active levels through 28 Oct should SSBCs precede the arrival of coronal hole fast winds, but this is low confidence.

There are a number of filaments on the visible disc that have the potential to disrupt or lift-off, producing CMEs. These will be monitored during the period, although no contribution to geomagnetic activity is currently included.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	10	10	40	60
Strong	G3	No	1	1	5	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs currently expected.

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Figure 2: SDO AIA-211 imagery comparing last rotation (left) to this rotation (right) showing the structure and position of coronal holes.

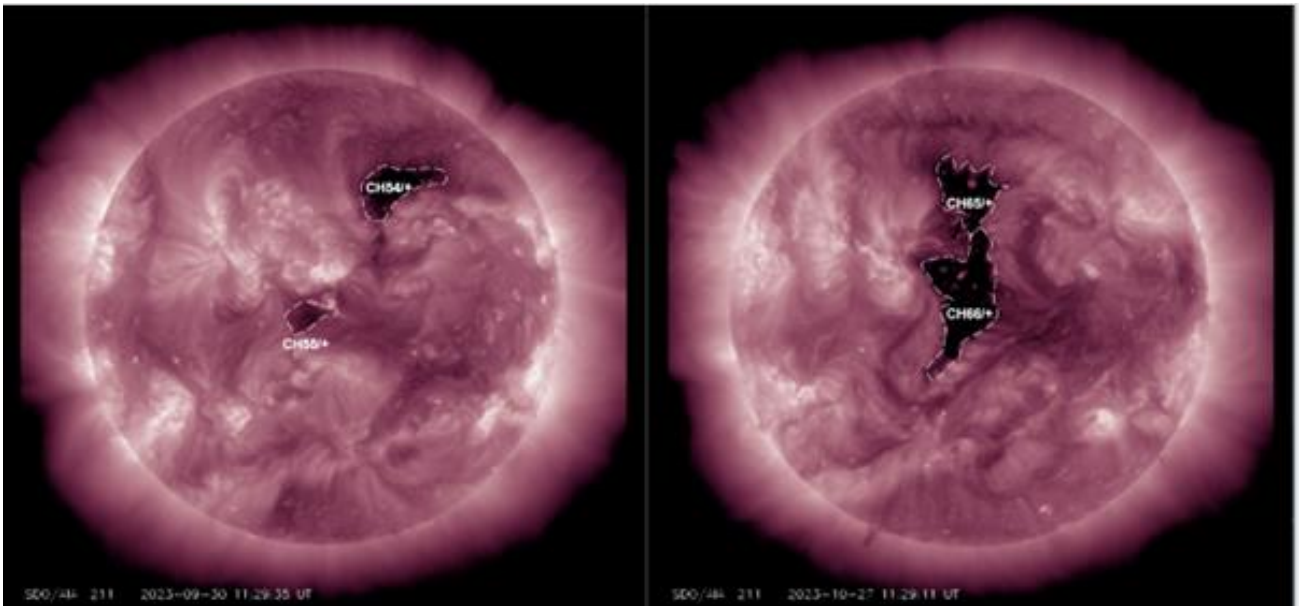
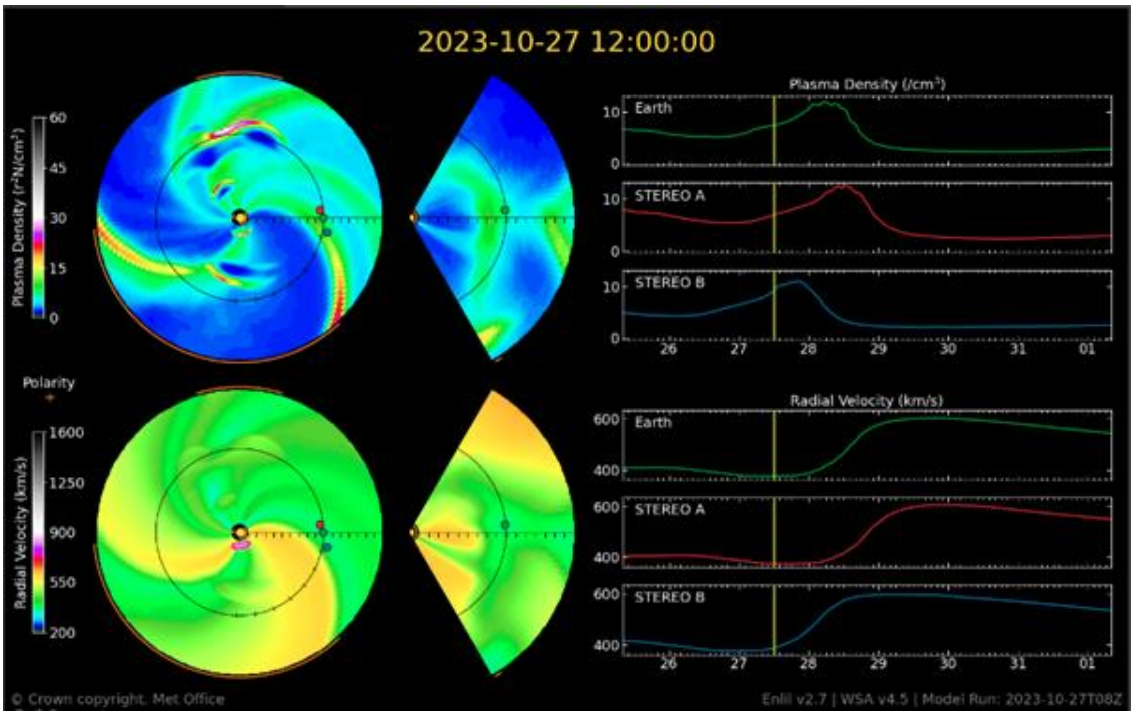


Figure 3: MOSWOC Enlil showing forecast onset of HSS from CH65/+ and CH66/+. The 0800Z run has an onset of fast winds late 28 Oct, considered to be about a day early.



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Radio Blackouts - X-Ray Flares:

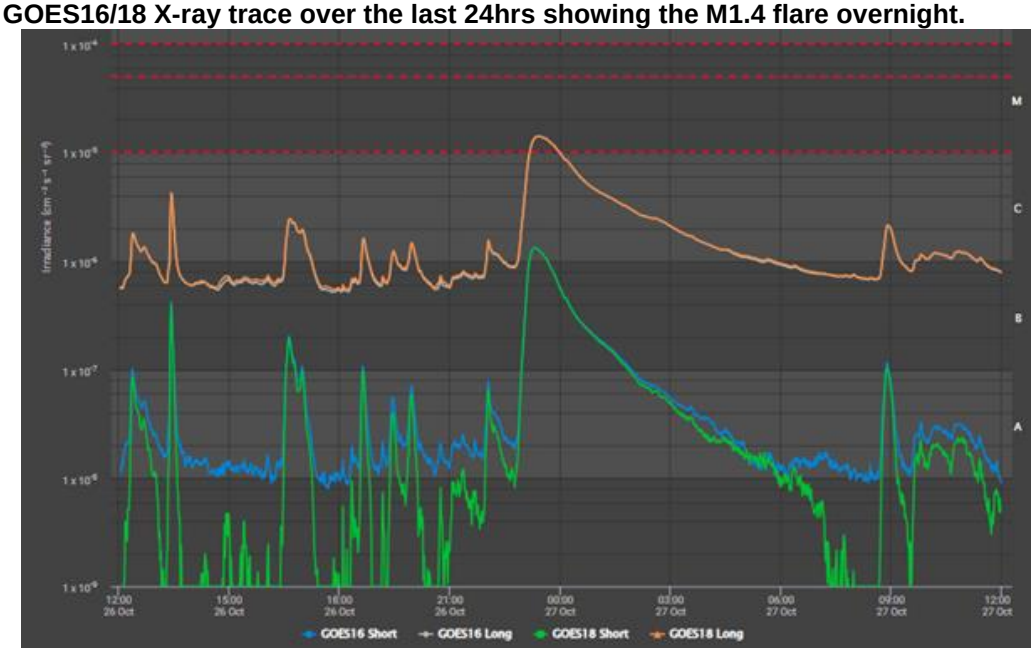
Low activity is expected with a slight, but increasing, chance of M-flares.

There are currently six regions on the visible disc. Two small regions lie on the south west disc, AR3468, a unipolar spot, and AR3471 (Cri/Beta), currently the most complex region on the disc. AR3473 (Cso/Beta) continues to emerge from the eastern limb and is currently a small sunspot group contained within a relatively large area of plage. This region lies close to where the filament lift-off occurred late 26 Oct, producing a M1.4 flare at 26/2624 UTC and releasing a non-earth directed CME. The other regions are small and simple, although one or two regions show faint signs of development.

There are a couple of bright regions visible on STEREO-EUVI imagery, suggesting the potential for new regions to emerge through Days 1-3 (27-29 Oct). One of these regions appears to be associated with the area of plage that contains AR3473 in the north east. A general increase in activity is expected given the current position in the solar cycle with further development of regions on the visible disc, namely flare-risk contributions from AR3471 in the south west and emerging AR3473. The combined effect of developing or returning regions is for an increase in flare risk through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	10	10	15	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES16/18 X-ray trace over the last 24hrs showing the M1.4 flare overnight.



Solar Radiation Storms - (High Energy Protons):

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The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels in the absence of significant sunspot regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

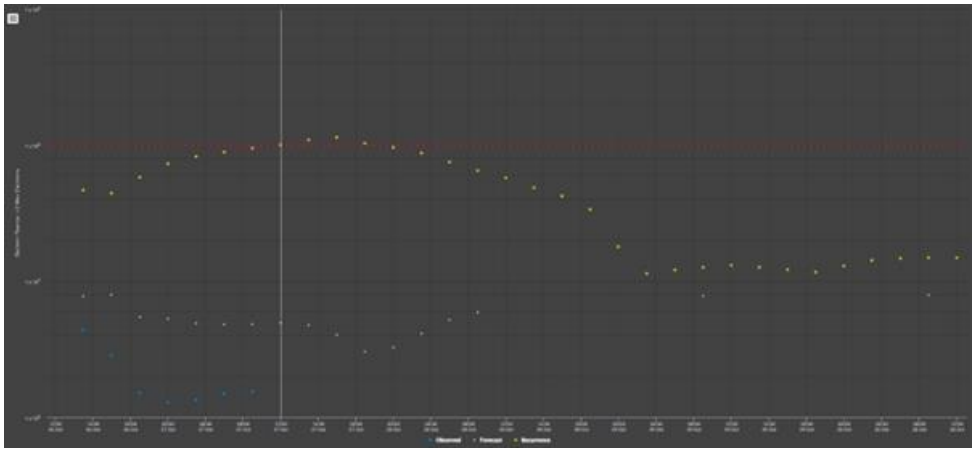
High Energy Electrons Event (≥ 2MeV):

Electron flux observed by GOES16 at GEO is currently at Background levels with only slight diurnal rises to Moderate expected. Some increase to electron populations through the Van Allen Belt is possible due to recent coronal hole enhancement from CH64, bringing a slight chance of reaching High at the diurnal peak by Day 2 (28 Oct). The following fast wind from CH65/+ and CH66/+, due Day 3 or 4 (29-30 Oct) is anticipated to have a more significant impact on electron populations. However, the electron response is likely to be suppressed until beyond the current forecast period (31 Oct onward).

The associated 24hr electron fluence is forecast to remain below the Active level. This is supported by REFM, though persistence provides a poor guide due to influence of CMEs on the previous rotation.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	5	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM showing forecast levels way beyond the Active threshold throughout.



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